

## **CHAPTER 8**

### **ALTERNATIVE EVALUATIONS**

Evaluations of the alternatives discussed in Chapter 7 are based on several factors and are discussed here.

#### **A. FINISHED WATER QUALITY**

Only those treatment alternatives discussed in Chapter 7 that would result in an acceptable water quality were pursued to any great degree. As a result the following options were investigated:

- Side Channel Storage
- Supplemental Groundwater
- Ion Exchange
- Reverse Osmosis

Each of these alternatives is capable of providing finished water with a nitrate level below the 9 mg/l goal. The alternatives were sized based on the requirements of providing a total blended effluent flow of 10 mgd below the nitrate 9 mg/l goal. Therefore, each alternative would be capable of providing a similar nitrate concentration in the finished water. Each process, however, would have different effects on the constituents of the finished water as a whole. These points are discussed in this section.

#### **1. Side Channel Storage**

The side channel storage option would store low nitrate water off site until it is required for blending due to nitrate levels at or above the 9 mg/l goal in Lake Vermilion. All other water quality parameters such as hardness, alkalinity, and turbidity should be relatively consistent with current Lake Vermilion values with the exception of synthetic organics, which are associated with non-point source agricultural runoff containing pesticides and herbicides. Periods of higher levels of synthetic organics typically correspond to periods of higher nitrates because they both originate from similar sources. Therefore, concentrations of these organics in addition to nitrate concentrations would be somewhat less when the side channel storage water is being utilized. CIWC worked previously with Daily & Associates Engineers, Inc., to investigate the feasibility of this alternative and their data was used to develop this information.

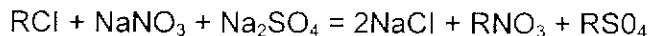
#### **2. Groundwater**

Typically, groundwater in the Danville area is relatively high in hardness, total dissolved solids, alkalinity and dissolved iron. If groundwater were to be blended with Lake Vermilion water in order to dilute the nitrate concentration to below the 9 mg/l goal, there would be corresponding increases in hardness as well as in the other parameters. These constituents could be removed through the existing treatment process by making appropriate adjustments in chemical feed rates. The finished water quality should be comparable to the current finished water quality for all parameters with the exception of the nitrate concentration, which would decrease.

### 3. Ion Exchange

The ion exchange process is a fundamentally different approach from the aforementioned alternatives in that it does not rely on a new water source that is lower in nitrate concentration but rather utilizes the same source water and treats it further to reduce the nitrate concentration.

The ion exchange system would be sized to treat a portion of the total plant flow such that the plant would be capable of producing 10 mgd of blended water with a nitrate concentration below 9 mg/l. The ion exchange process would also remove sulfates from the feed water as they also exhibit a strong affinity for the resins. The resins would exchange chlorides for nitrates and sulfates according to the following reaction where R designates the ion exchange resin:



Therefore, the chloride concentration of the finished water would increase by approximately two times. No MCL exists for chloride, but the secondary (aesthetic) standard for chloride is 250 mg/l to avoid a saltwater taste. The blended finished water should be well below this standard.

### 4. Reverse Osmosis

The reverse osmosis (RO) process would also be sized to treat only a portion of the raw water to maintain a blended finished water nitrate concentration below the 9 mg/l goal. Similar to ion exchange, the reverse osmosis unit would treat a percentage of the conventionally treated water from the Lake Vermilion source. As discussed in Chapter 7 of this report, RO is capable of removing all but the smallest molecular compounds. RO is especially suited to remove long chained organic molecules such as atrazine, simazine and cynazine, which have been found in small amounts in Lake Vermilion sourcewater. In addition to removal of these compounds, other organics that may be present and that could be potential THM precursors would be removed by RO. These compounds would not be entirely removed, however, since only about 45% of the total blended flow would be treated through the RO process. All basic parameters of the RO treated water would be well below their respective MCL's. Table 8-1 delineates some of the expected permeate values.

**TABLE 8-1**  
**RO PERMEATE CONCENTRATIONS (mg/l)**

Ion	Raw Water		Feed Water		Permeate		Concentrate	
	mg/l	as mg/l CaCO <sub>3</sub>	mg/l	as mg/l CaCO <sub>3</sub>	mg/l	as mg/l CaCO <sub>3</sub>	mg/l	as mg/l CaCO <sub>3</sub>
Ca	38.8	96.7	38.8	96.7	0.6	1.4	153.4	382.6
Mg	11.1	45.5	11.1	45.5	0.2	0.7	43.8	180.0
Na	21.3	NA	21.3	NA	1.4	NA	80.7	NA
K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH <sub>4</sub>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO <sub>3</sub>	1.2	2.0	1.2	2.0	0.0	0.0	4.9	8.2
HCO <sub>3</sub>	56.5	46.3	56.5	46.3	1.2	1.0	222.3	182.2
SO <sub>4</sub>	37.2	NA	37.2	NA	0.1	NA	148.5	NA
Cl	28.4	NA	28.4	NA	0.3	NA	112.6	NA
F	1.2	NA	1.2	NA	0.0	NA	4.6	NA
NO <sub>3</sub>	71.8	NA	71.8	NA	4.3	NA	274.1	NA
SiO <sub>2</sub>	5.0	NA	5.0	NA	0.0	NA	19.9	NA
TDS	272.3	NA	272.3	NA	8.3	NA	1064.8	NA
pH	8.8	NA	8.8	NA	7.2	NA	8.9	NA

NA – Not Applicable

An additional benefit of the RO process is the removal of microscopic particulates to non-detectable levels. This includes particulates down to the macro molecular range, which is much less than the size of microorganisms of concern. Table 8-2 illustrates this point.

**TABLE 8-2**  
**SIZE COMPARISON**

RO retainage	>0.001 – 0.0001 µm
<i>Giardia</i> cysts	5 – 15 µm
<i>Cryptosporidium</i> oocyst	3 – 5 µm
Coliform bacteria	0.1 – 10 µm
Viruses	0.02 – 0.03 µm

Based on the above discussion, the RO alternative should provide the best quality water. Although, all of the alternatives considered would provide acceptable finished water quality.

## A. ECONOMICS

The economic analysis of each of the alternatives investigated is shown below. Each major alternative has been estimated for capital and annual operating costs. These costs were then utilized to project an annual present value of revenue required to meet these costs. As outlined in the design criteria, previously in this report, the period of nitrate treatment operation is assumed to be 90 days over a three year period. Therefore, for cost analyses purposes, this 90- day period was normalized to 30 days per year. Each of the cost estimates presented includes a 20 percent contingency factor. Also, each of the alternatives contains water treatment plant improvements that CTE evaluated and recommended to meet upcoming regulations. They include slurry carbon system, filter improvements, constructing new river intakes, and upgrading the SCADA system.

### 1. Side Channel Storage

**TABLE 8-3  
SIDE CHANNEL STORAGE AT CANYON LAKE SITE  
ESTIMATED CAPITAL COSTS**

<b>DESCRIPTION</b>	<b>QUANTITY</b>	<b>UNITS</b>	<b>UNIT COST</b>	<b>TOTAL COST</b>
*24" Transmission Main	24,000	LF	\$70	\$1,680,000
Pump Stations	2	LS	\$350,000	\$700,000
Intake Structures	2	LS	\$375,000	\$750,000
Earthwork for Reservoir	1	LS	\$2,900,000	\$2,900,000
Land Acquisition and Easements	1	LS	\$900,000	\$900,000
Other Water Treatment Plant Improvements <sup>1</sup>	1	LS	\$1,040,000	\$1,040,000
Sub-Total				\$7,970,000
20% Contingency				\$1,594,000
Total Construction Cost				\$9,564,000
Other Project Costs				\$3,372,290
<b>Total Project Cost</b>				<b>\$12,936,290</b>
*Assumes the use of HDPE Transmission Main				

<sup>1</sup>CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

**TABLE 8-4**  
**SIDE CHANNEL STORAGE AT CANYON LAKE SITE**  
**ESTIMATED OPERATING COSTS**

<b>DESCRIPTION</b>	<b>QUANTITY</b>	<b>UNIT</b>	<b>UNIT PRICE</b>	<b>COST/YR</b>
Pumping Cost	1	LS	\$15,000	\$15,000
Water quality Monitoring & Watershed Mgt.	1	LS	\$30,000	\$30,000
<b>Total</b>				<b>\$45,000</b>

**TABLE 8-5**  
**SIDE CHANNEL STORAGE AT CANYON LAKE SITE**  
**PRESENT VALUE OF REVENUE REQUIRED**

A	B	C	D	E	F	G	H	I	J	K	P.V. of Revenue Requirement
Year	Total Capital Cost	Year - End Undepr. Factor	Undepr. Capital	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (Excluding Land) (B x 2.5%)	Property Taxes @ 2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	@ 10%
1	\$12,936,290	0.975	\$12,633,883	17.00%	\$2,147,760	\$45,000	\$302,407	\$252,678	\$2,702,845	\$2,747,845	\$2,498,041
2	\$12,936,290	0.950	\$12,331,476	17.00%	\$2,096,351	\$46,350	\$302,407	\$246,630	\$2,645,388	\$2,691,738	\$2,224,577
3	\$12,936,290	0.925	\$12,029,068	17.00%	\$2,044,942	\$47,741	\$302,407	\$240,581	\$2,587,930	\$2,635,671	\$1,980,218
4	\$12,936,290	0.900	\$11,726,661	17.00%	\$1,993,532	\$49,173	\$302,407	\$234,533	\$2,530,473	\$2,579,646	\$1,761,933
5	\$12,936,290	0.875	\$11,424,254	17.00%	\$1,942,123	\$50,648	\$302,407	\$228,485	\$2,473,015	\$2,523,663	\$1,566,996
6	\$12,936,290	0.850	\$11,121,847	17.00%	\$1,890,714	\$52,167	\$302,407	\$222,437	\$2,415,558	\$2,467,725	\$1,392,967
7	\$12,936,290	0.825	\$10,819,439	17.00%	\$1,839,305	\$53,732	\$302,407	\$216,389	\$2,358,101	\$2,411,833	\$1,237,652
8	\$12,936,290	0.800	\$10,517,032	17.00%	\$1,787,895	\$55,344	\$302,407	\$210,341	\$2,300,643	\$2,355,988	\$1,099,086
9	\$12,936,290	0.775	\$10,214,625	17.00%	\$1,736,486	\$57,005	\$302,407	\$204,292	\$2,243,186	\$2,300,191	\$975,505
10	\$12,936,290	0.750	\$9,912,218	17.00%	\$1,685,077	\$58,715	\$302,407	\$198,244	\$2,185,729	\$2,244,443	\$865,330
11	\$12,936,290	0.725	\$9,609,810	17.00%	\$1,633,668	\$60,476	\$302,407	\$192,196	\$2,128,271	\$2,188,747	\$767,143
12	\$12,936,290	0.700	\$9,307,403	17.00%	\$1,582,259	\$62,291	\$302,407	\$186,148	\$2,070,814	\$2,133,104	\$679,673
13	\$12,936,290	0.675	\$9,004,996	17.00%	\$1,530,849	\$64,159	\$302,407	\$180,100	\$2,013,356	\$2,077,516	\$601,782
14	\$12,936,290	0.650	\$8,702,589	17.00%	\$1,479,440	\$66,084	\$302,407	\$174,052	\$1,955,899	\$2,021,983	\$532,451
15	\$12,936,290	0.625	\$8,400,181	17.00%	\$1,428,031	\$68,067	\$302,407	\$168,004	\$1,898,442	\$1,966,508	\$470,766
16	\$12,936,290	0.600	\$8,097,774	17.00%	\$1,376,622	\$70,109	\$302,407	\$161,955	\$1,840,984	\$1,911,093	\$415,909
17	\$12,936,290	0.575	\$7,795,367	17.00%	\$1,325,212	\$72,212	\$302,407	\$155,907	\$1,783,527	\$1,855,739	\$367,148
18	\$12,936,290	0.550	\$7,492,960	17.00%	\$1,273,803	\$74,378	\$302,407	\$149,859	\$1,726,070	\$1,800,448	\$323,826
19	\$12,936,290	0.525	\$7,190,552	17.00%	\$1,222,394	\$76,609	\$302,407	\$143,811	\$1,668,612	\$1,745,222	\$285,358
20	\$12,936,290	0.500	\$6,888,145	17.00%	\$1,170,985	\$78,908	\$302,407	\$137,763	\$1,611,155	\$1,690,063	\$251,217
21	\$12,936,290	0.475	\$6,585,738	17.00%	\$1,119,575	\$81,275	\$302,407	\$131,715	\$1,553,697	\$1,634,972	\$220,935
22	\$12,936,290	0.450	\$6,283,331	17.00%	\$1,068,166	\$83,713	\$302,407	\$125,667	\$1,496,240	\$1,579,953	\$194,091
23	\$12,936,290	0.425	\$5,980,923	17.00%	\$1,016,757	\$86,225	\$302,407	\$119,618	\$1,438,783	\$1,525,007	\$170,310
24	\$12,936,290	0.400	\$5,678,516	17.00%	\$965,348	\$88,811	\$302,407	\$113,570	\$1,381,325	\$1,470,137	\$149,257
25	\$12,936,290	0.375	\$5,376,109	17.00%	\$913,938	\$91,476	\$302,407	\$107,522	\$1,323,868	\$1,415,344	\$130,631
26	\$12,936,290	0.350	\$5,073,702	17.00%	\$862,529	\$94,220	\$302,407	\$101,474	\$1,266,411	\$1,360,631	\$114,164
27	\$12,936,290	0.325	\$4,771,294	17.00%	\$811,120	\$97,047	\$302,407	\$95,426	\$1,208,953	\$1,306,000	\$99,619
28	\$12,936,290	0.300	\$4,468,887	17.00%	\$759,711	\$99,958	\$302,407	\$89,378	\$1,151,496	\$1,251,454	\$86,780
29	\$12,936,290	0.275	\$4,166,480	17.00%	\$708,302	\$102,957	\$302,407	\$83,330	\$1,094,038	\$1,196,995	\$75,458
30	\$12,936,290	0.250	\$3,864,073	17.00%	\$656,892	\$106,045	\$302,407	\$77,281	\$1,036,581	\$1,142,626	\$65,482
										<b>TOTAL:</b>	\$21,604,304

\* An annual inflation rate of 3% has been applied to the total O&M expense.

## 2. Groundwater

**TABLE 8-6  
GROUNDWATER ALTERNATIVE  
ESTIMATED CAPITAL COSTS**

DESCRIPTION	QUANTITY	UNITS	UNIT COST	TOTAL COST
*20" Pipeline	79,200	LF	\$65	\$5,148,000
Wells, including pumps, shafts, structures, and access @ 1 mgd each	4	EA	\$200,000	\$800,000
Land Acquisition and Easements	1	LS	\$300,000	\$300,000
Legal Costs	1	LS	\$500,000	\$500,000
Other Water Treatment Plant Improvements <sup>1</sup>	1	LS	\$1,040,000	\$1,040,000
Sub-Total				\$7,788,000
20% Contingency				\$1,557,600
Total Construction Cost				\$9,345,600
Other Project Costs				\$3,317,690
<b>Total Project Cost</b>				<b>\$12,663,290</b>
*Assumes the use of HDPE transmission main				

<sup>1</sup>CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

**TABLE 8-7  
GROUNDWATER ALTERNATIVE  
ESTIMATED OPERATING COSTS**

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST/YR
Power	1	LS	\$10,000	\$10,000
Heating	1	LS	\$10,000	\$10,000
Supplies	1	LS	\$5000	\$5000
<b>Total</b>				<b>\$25,000</b>

**TABLE 8-8**  
**GROUNDWATER ALTERNATIVE**  
**PRESENT VALUE OF REVENUE REQUIRED**

A	B	C	D	E	F	G	H	I	J	K	P.V. of
Year	Total Capital Cost	Year - En Undepr. Factor	Undepreciated Capital (B x C)	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (B x 2.50%)	Property Taxes @ 2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	Revenue Requirement @ 10%
1	\$12,663,290	0.975	\$12,346,708	17.00%	\$2,098,940	\$25,000	\$316,582	\$246,934	\$2,662,457	\$2,687,457	\$2,443,142
2	\$12,663,290	0.950	\$12,030,126	17.00%	\$2,045,121	\$25,750	\$316,582	\$240,603	\$2,602,306	\$2,628,056	\$2,171,947
3	\$12,663,290	0.925	\$11,713,543	17.00%	\$1,991,302	\$26,523	\$316,582	\$234,271	\$2,542,155	\$2,568,678	\$1,929,886
4	\$12,663,290	0.900	\$11,396,961	17.00%	\$1,937,483	\$27,318	\$316,582	\$227,939	\$2,482,005	\$2,509,323	\$1,713,901
5	\$12,663,290	0.875	\$11,080,379	17.00%	\$1,883,664	\$28,138	\$316,582	\$221,608	\$2,421,854	\$2,449,992	\$1,521,252
6	\$12,663,290	0.850	\$10,763,797	17.00%	\$1,829,845	\$28,982	\$316,582	\$215,276	\$2,361,704	\$2,390,685	\$1,349,480
7	\$12,663,290	0.825	\$10,447,214	17.00%	\$1,776,026	\$29,851	\$316,582	\$208,944	\$2,301,553	\$2,331,404	\$1,196,379
8	\$12,663,290	0.800	\$10,130,632	17.00%	\$1,722,207	\$30,747	\$316,582	\$202,613	\$2,241,402	\$2,272,149	\$1,059,974
9	\$12,663,290	0.775	\$9,814,050	17.00%	\$1,668,388	\$31,669	\$316,582	\$196,281	\$2,181,252	\$2,212,921	\$938,495
10	\$12,663,290	0.750	\$9,497,468	17.00%	\$1,614,569	\$32,619	\$316,582	\$189,949	\$2,121,101	\$2,153,720	\$800,352
11	\$12,663,290	0.725	\$9,180,885	17.00%	\$1,560,750	\$33,598	\$316,582	\$183,618	\$2,060,950	\$2,094,548	\$734,126
12	\$12,663,290	0.700	\$8,864,303	17.00%	\$1,506,932	\$34,606	\$316,582	\$177,286	\$2,000,800	\$2,035,406	\$648,543
13	\$12,663,290	0.675	\$8,547,721	17.00%	\$1,453,113	\$35,644	\$316,582	\$170,954	\$1,940,649	\$1,976,293	\$572,462
14	\$12,663,290	0.650	\$8,231,139	17.00%	\$1,399,294	\$36,713	\$316,582	\$164,623	\$1,880,499	\$1,917,212	\$504,862
15	\$12,663,290	0.625	\$7,914,556	17.00%	\$1,345,475	\$37,815	\$316,582	\$158,291	\$1,820,348	\$1,858,163	\$444,829
16	\$12,663,290	0.600	\$7,597,974	17.00%	\$1,291,656	\$38,949	\$316,582	\$151,959	\$1,760,197	\$1,799,146	\$391,547
17	\$12,663,290	0.575	\$7,281,392	17.00%	\$1,237,837	\$40,118	\$316,582	\$145,628	\$1,700,047	\$1,740,164	\$344,282
18	\$12,663,290	0.550	\$6,964,810	17.00%	\$1,184,018	\$41,321	\$316,582	\$139,296	\$1,639,896	\$1,681,217	\$302,382
19	\$12,663,290	0.525	\$6,648,227	17.00%	\$1,130,199	\$42,561	\$316,582	\$132,965	\$1,579,745	\$1,622,306	\$265,260
20	\$12,663,290	0.500	\$6,331,645	17.00%	\$1,076,380	\$43,838	\$316,582	\$126,633	\$1,519,595	\$1,563,432	\$232,394
21	\$12,663,290	0.475	\$6,015,063	17.00%	\$1,022,561	\$45,153	\$316,582	\$120,301	\$1,459,444	\$1,504,597	\$203,317
22	\$12,663,290	0.450	\$5,698,480	17.00%	\$968,742	\$46,507	\$316,582	\$113,970	\$1,399,294	\$1,445,801	\$177,611
23	\$12,663,290	0.425	\$5,381,898	17.00%	\$914,923	\$47,903	\$316,582	\$107,638	\$1,339,143	\$1,387,046	\$154,903
24	\$12,663,290	0.400	\$5,065,316	17.00%	\$861,104	\$49,340	\$316,582	\$101,306	\$1,278,992	\$1,328,332	\$134,860
25	\$12,663,290	0.375	\$4,748,734	17.00%	\$807,285	\$50,820	\$316,582	\$94,975	\$1,218,842	\$1,269,662	\$117,185
26	\$12,663,290	0.350	\$4,432,151	17.00%	\$753,466	\$52,344	\$316,582	\$88,643	\$1,158,691	\$1,211,035	\$101,612
27	\$12,663,290	0.325	\$4,115,569	17.00%	\$699,647	\$53,915	\$316,582	\$82,311	\$1,098,540	\$1,152,455	\$87,907
28	\$12,663,290	0.300	\$3,798,987	17.00%	\$645,828	\$55,532	\$316,582	\$75,980	\$1,038,390	\$1,093,922	\$75,856
29	\$12,663,290	0.275	\$3,482,405	17.00%	\$592,009	\$57,198	\$316,582	\$69,648	\$978,239	\$1,035,437	\$65,273
30	\$12,663,290	0.250	\$3,165,822	17.00%	\$538,190	\$58,914	\$316,582	\$63,316	\$918,089	\$977,003	\$55,991
										<b>TOTAL:</b>	\$20,770,010

\* An annual inflation rate of 3% has been applied to the total O&M expense.



### 3. Ion Exchange

**TABLE 8-9  
ION EXCHANGE CO-CURRENT ALTERNATIVE  
ESTIMATED CAPITAL COSTS**

<b>DESCRIPTION</b>	<b>QUANTITY</b>	<b>UNITS</b>	<b>UNIT COST</b>	<b>TOTAL COST</b>
Ion Exchange Equipment	1	LS	\$815,000	\$815,000
Ion Exchange Facilities	1	LS	\$1,142,000	\$1,142,000
Booster Pump Station	1	LS	\$128,000	\$128,000
Plant Piping	1	LS	\$194,000	\$194,000
Waste Water Disposal to San. Sewer	1	LS	\$125,000	\$125,000
Sanitary Sewer Improvements	1	LS	\$100,000	\$100,000
Slurry Carbon System <sup>1</sup>	1	LS	\$339,000	\$339,000
Filter Improvements <sup>1</sup>	1	LS	\$77,000	\$77,000
New River Intake <sup>1</sup>	1	LS	\$324,000	\$324,000
Upgrading SCADA System <sup>1</sup>	1	LS	\$300,000	\$300,000
Sub-Total				\$3,544,000
20% Contingency				\$ 708,800
Total Construction Cost				\$4,252,800
Other Project Costs				\$2,044,490
<b>Total Project Cost</b>				<b>\$6,297,290</b>

<sup>1</sup>CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

**TABLE 8-10**  
**ION EXCHANGE CO-CURRENT ALTERNATIVE**  
**ESTIMATED OPERATING COSTS**

<b>DESCRIPTION</b>	<b>TOTAL/YR</b>	<b>COST/YR</b>
Pumping Costs	85.7 MG	\$1425
Salt Cost	340,400 lb	\$11,920
Wastewater Volume Charge	1.63 MG	\$91,120
Sulfate Wastewater Charge	28,600 lb	\$16,390
Resin Replacement Cost	1256 cu ft	\$6,775
<b>Total</b>		<b>\$127,630</b>
	<b>SAY</b>	<b>\$128,000</b>

**TABLE 8-11**  
**ION EXCHANGE CO-CURRENT ALTERNATIVE**  
**PRESENT VALUE OF REVENUE REQUIRED**

A	B	C	D	E	F	G	H	I	J	K	P.V. of Revenue Requirement @ 10%
Year	Total Capital Cost	Year - End Undepr. Factor	Undepreciated Capital	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (B x 3.0%)	Property Taxes @2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	
1	\$6,297,290	0.970	\$6,108,371	17.00%	\$1,038,423	\$128,000	\$188,919	\$122,167	\$1,349,509	\$1,477,509	\$1,343,190
2	\$6,297,290	0.945	\$5,919,453	17.00%	\$1,006,307	\$131,840	\$188,919	\$118,389	\$1,313,615	\$1,445,455	\$1,194,591
3	\$6,297,290	0.920	\$5,730,534	17.00%	\$974,191	\$135,795	\$188,919	\$114,611	\$1,277,720	\$1,413,515	\$1,061,995
4	\$6,297,290	0.895	\$5,541,615	17.00%	\$942,075	\$139,869	\$188,919	\$110,832	\$1,241,826	\$1,381,695	\$943,716
5	\$6,297,290	0.870	\$5,352,697	17.00%	\$909,958	\$144,065	\$188,919	\$107,054	\$1,205,931	\$1,349,996	\$838,241
6	\$6,297,290	0.845	\$5,163,778	17.00%	\$877,842	\$148,387	\$188,919	\$103,276	\$1,170,036	\$1,318,424	\$744,216
7	\$6,297,290	0.820	\$4,974,859	17.00%	\$845,726	\$152,839	\$188,919	\$99,497	\$1,134,142	\$1,286,981	\$660,425
8	\$6,297,290	0.795	\$4,785,940	17.00%	\$813,610	\$157,424	\$188,919	\$95,719	\$1,098,247	\$1,255,671	\$585,780
9	\$6,297,290	0.770	\$4,597,022	17.00%	\$781,494	\$162,147	\$188,919	\$91,940	\$1,062,353	\$1,224,499	\$519,307
10	\$6,297,290	0.745	\$4,408,103	17.00%	\$749,378	\$167,011	\$188,919	\$88,162	\$1,026,458	\$1,193,469	\$460,134
11	\$6,297,290	0.720	\$4,219,184	17.00%	\$717,261	\$172,021	\$188,919	\$84,384	\$990,564	\$1,162,585	\$407,479
12	\$6,297,290	0.695	\$4,030,266	17.00%	\$685,145	\$177,182	\$188,919	\$80,605	\$954,669	\$1,131,851	\$360,643
13	\$6,297,290	0.670	\$3,841,347	17.00%	\$653,029	\$182,497	\$188,919	\$76,827	\$918,775	\$1,101,272	\$318,999
14	\$6,297,290	0.645	\$3,652,428	17.00%	\$620,913	\$187,972	\$188,919	\$73,049	\$882,880	\$1,070,852	\$281,989
15	\$6,297,290	0.620	\$3,463,510	17.00%	\$588,797	\$193,611	\$188,919	\$69,270	\$846,986	\$1,040,597	\$249,111
16	\$6,297,290	0.595	\$3,274,591	17.00%	\$556,680	\$199,420	\$188,919	\$65,492	\$811,091	\$1,010,511	\$219,917
17	\$6,297,290	0.570	\$3,085,672	17.00%	\$524,564	\$205,402	\$188,919	\$61,713	\$775,196	\$980,599	\$194,006
18	\$6,297,290	0.545	\$2,896,753	17.00%	\$492,448	\$211,564	\$188,919	\$57,935	\$739,302	\$950,866	\$171,022
19	\$6,297,290	0.520	\$2,707,835	17.00%	\$460,332	\$217,911	\$188,919	\$54,157	\$703,407	\$921,319	\$150,643
20	\$6,297,290	0.495	\$2,518,916	17.00%	\$428,216	\$224,449	\$188,919	\$50,378	\$667,513	\$891,962	\$132,584
21	\$6,297,290	0.470	\$2,329,997	17.00%	\$396,100	\$231,182	\$188,919	\$46,600	\$631,618	\$862,800	\$116,591
22	\$6,297,290	0.445	\$2,141,079	17.00%	\$363,983	\$238,118	\$188,919	\$42,822	\$595,724	\$833,841	\$102,434
23	\$6,297,290	0.420	\$1,952,160	17.00%	\$331,867	\$245,261	\$188,919	\$39,043	\$559,829	\$805,090	\$89,911
24	\$6,297,290	0.395	\$1,763,241	17.00%	\$299,751	\$252,619	\$188,919	\$35,265	\$523,935	\$776,554	\$78,840
25	\$6,297,290	0.370	\$1,574,323	17.00%	\$267,635	\$260,198	\$188,919	\$31,486	\$488,040	\$748,238	\$69,059
26	\$6,297,290	0.345	\$1,385,404	17.00%	\$235,519	\$268,004	\$188,919	\$27,708	\$452,145	\$720,149	\$60,424
27	\$6,297,290	0.320	\$1,196,485	17.00%	\$203,402	\$276,044	\$188,919	\$23,930	\$416,251	\$692,295	\$52,807
28	\$6,297,290	0.295	\$1,007,566	17.00%	\$171,286	\$284,325	\$188,919	\$20,151	\$380,356	\$664,681	\$46,091
29	\$6,297,290	0.270	\$818,648	17.00%	\$139,170	\$292,855	\$188,919	\$16,373	\$344,462	\$637,317	\$40,176
30	\$6,297,290	0.245	\$629,729	17.00%	\$107,054	\$301,640	\$188,919	\$12,595	\$308,567	\$610,208	\$34,970
										<b>TOTAL:</b>	\$11,529,291

\* An annual inflation rate of 3% has been applied to the total O&M expense.

**TABLE 8-12**  
**ION EXCHANGE COUNTER-CURRENT ALTERNATIVE**  
**ESTIMATED CAPITAL COSTS**

<b>DESCRIPTION</b>	<b>QUANTITY</b>	<b>UNITS</b>	<b>UNIT COST</b>	<b>TOTAL COST</b>
Ion Exchange Equipment	1	LS	\$870,000	\$870,000
Ion Exchange Facilities	1	LS	\$1,142,000	\$1,142,000
Booster Pump Station	1	LS	\$128,000	\$128,000
Plant Piping	1	LS	\$194,000	\$194,000
Waste Water Disposal to San. Sewer	1	LS	\$125,000	\$125,000
Sanitary Sewer Improvements	1	LS	\$100,000	\$100,000
Slurry Carbon System <sup>1</sup>	1	LS	\$339,000	\$339,000
Filter Improvements <sup>1</sup>	1	LS	\$77,000	\$77,000
New River Intake <sup>1</sup>	1	LS	\$324,000	\$324,000
Upgrading SCADA System <sup>1</sup>	1	LS	\$300,000	\$300,000
Sub-Total				\$3,599,000
20% Contingency				\$ 719,800
Total Construction Cost				\$4,318,800
Other Project Costs				\$2,060,990
<b>Total Project Cost</b>				<b>\$6,379,790</b>

<sup>1</sup>CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

**TABLE 8-13**  
**ION EXCHANGE COUNTER-CURRENT ALTERNATIVE**  
**ESTIMATED OPERATING COSTS**

<b>DESCRIPTION</b>	<b>TOTAL/YR</b>	<b>COST/YR</b>
Pumping Costs	78.7 MG	\$1310
Salt Cost	209,500 lb	\$7340
Wastewater Volume Charge	1.138 MG	\$63,620
Sulfate Wastewater Charge	26,200 lb	\$15,020
Resin Replacement Cost	1572 cu ft	\$8500
<b>Total</b>		<b>\$95,790</b>
	<b>SAY</b>	<b>\$100,000</b>

**TABLE 8-14**  
**ION EXCHANGE COUNTER-CURRENT ALTERNATIVE**  
**PRESENT VALUE OF REVENUE REQUIRED**

A	B	C	D	E	F	G	H	I	J	K	P.V. of Revenue Requirement
Year	Total Capital Cost	Year - End Undepr. Factor	Undepreciated Capital	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (B x 3.0%)	Property Taxes @2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	@ 10%
1	\$6,379,790	0.970	\$6,188,396	17.00%	\$1,052,027	\$100,000	\$191,394	\$123,768	\$1,367,189	\$1,467,189	\$1,333,808
2	\$6,379,790	0.945	\$5,997,003	17.00%	\$1,019,490	\$103,000	\$191,394	\$119,940	\$1,330,824	\$1,433,824	\$1,184,979
3	\$6,379,790	0.920	\$5,805,609	17.00%	\$986,954	\$106,090	\$191,394	\$116,112	\$1,294,459	\$1,400,549	\$1,052,253
4	\$6,379,790	0.895	\$5,614,215	17.00%	\$954,417	\$109,273	\$191,394	\$112,284	\$1,258,095	\$1,367,367	\$933,930
5	\$6,379,790	0.870	\$5,422,822	17.00%	\$921,880	\$112,551	\$191,394	\$108,456	\$1,221,730	\$1,334,281	\$828,483
6	\$6,379,790	0.845	\$5,231,428	17.00%	\$889,343	\$115,927	\$191,394	\$104,629	\$1,185,365	\$1,301,292	\$734,546
7	\$6,379,790	0.820	\$5,040,034	17.00%	\$856,806	\$119,405	\$191,394	\$100,801	\$1,149,000	\$1,268,405	\$650,893
8	\$6,379,790	0.795	\$4,848,640	17.00%	\$824,269	\$122,987	\$191,394	\$96,973	\$1,112,635	\$1,235,623	\$576,427
9	\$6,379,790	0.770	\$4,657,247	17.00%	\$791,732	\$126,677	\$191,394	\$93,145	\$1,076,271	\$1,202,948	\$510,167
10	\$6,379,790	0.745	\$4,465,853	17.00%	\$759,195	\$130,477	\$191,394	\$89,317	\$1,039,906	\$1,170,383	\$451,233
11	\$6,379,790	0.720	\$4,274,459	17.00%	\$726,658	\$134,392	\$191,394	\$85,489	\$1,003,541	\$1,137,933	\$398,838
12	\$6,379,790	0.695	\$4,083,066	17.00%	\$694,121	\$138,423	\$191,394	\$81,661	\$967,176	\$1,105,600	\$352,278
13	\$6,379,790	0.670	\$3,891,672	17.00%	\$661,584	\$142,576	\$191,394	\$77,833	\$930,811	\$1,073,387	\$310,922
14	\$6,379,790	0.645	\$3,700,278	17.00%	\$629,047	\$146,853	\$191,394	\$74,006	\$894,447	\$1,041,300	\$274,207
15	\$6,379,790	0.620	\$3,508,885	17.00%	\$596,510	\$151,259	\$191,394	\$70,178	\$858,082	\$1,009,341	\$241,628
16	\$6,379,790	0.595	\$3,317,491	17.00%	\$563,973	\$155,797	\$191,394	\$66,350	\$821,717	\$977,514	\$212,735
17	\$6,379,790	0.570	\$3,126,097	17.00%	\$531,437	\$160,471	\$191,394	\$62,522	\$785,352	\$945,823	\$187,126
18	\$6,379,790	0.545	\$2,934,703	17.00%	\$498,900	\$165,285	\$191,394	\$58,694	\$748,987	\$914,272	\$164,440
19	\$6,379,790	0.520	\$2,743,310	17.00%	\$466,363	\$170,243	\$191,394	\$54,866	\$712,623	\$882,866	\$144,356
20	\$6,379,790	0.495	\$2,551,916	17.00%	\$433,826	\$175,351	\$191,394	\$51,038	\$676,258	\$851,608	\$126,586
21	\$6,379,790	0.470	\$2,360,522	17.00%	\$401,289	\$180,611	\$191,394	\$47,210	\$639,893	\$820,504	\$110,875
22	\$6,379,790	0.445	\$2,169,129	17.00%	\$368,752	\$186,029	\$191,394	\$43,383	\$603,528	\$789,558	\$96,994
23	\$6,379,790	0.420	\$1,977,735	17.00%	\$336,215	\$191,610	\$191,394	\$39,555	\$567,163	\$758,774	\$84,738
24	\$6,379,790	0.395	\$1,786,341	17.00%	\$303,678	\$197,359	\$191,394	\$35,727	\$530,799	\$728,157	\$73,927
25	\$6,379,790	0.370	\$1,594,948	17.00%	\$271,141	\$203,279	\$191,394	\$31,899	\$494,434	\$697,713	\$64,396
26	\$6,379,790	0.345	\$1,403,554	17.00%	\$238,604	\$209,378	\$191,394	\$28,071	\$458,069	\$667,447	\$56,002
27	\$6,379,790	0.320	\$1,212,160	17.00%	\$206,067	\$215,659	\$191,394	\$24,243	\$421,704	\$637,363	\$48,617
28	\$6,379,790	0.295	\$1,020,766	17.00%	\$173,530	\$222,129	\$191,394	\$20,415	\$385,339	\$607,468	\$42,124
29	\$6,379,790	0.270	\$829,373	17.00%	\$140,993	\$228,793	\$191,394	\$16,587	\$348,975	\$577,767	\$36,422
30	\$6,379,790	0.245	\$637,979	17.00%	\$108,456	\$235,657	\$191,394	\$12,760	\$312,610	\$548,266	\$31,420
										<b>TOTAL:</b>	<b>\$11,315,352</b>

\* An annual inflation rate of 3% has been applied to the total O&M expense.

**TABLE 8-15**  
**ION EXCHANGE CONTINUOUS CONTACTOR ALTERNATIVE**  
**ESTIMATED CAPITAL COSTS**

<b>DESCRIPTION</b>	<b>QUANTITY</b>	<b>UNITS</b>	<b>UNIT COST</b>	<b>TOTAL COST</b>
Ion Exchange Equipment	1	LS	\$1,880,000	\$1,880,000
Ion Exchange Facilities	1	LS	\$1,142,000	\$1,142,000
Booster Pump Station	1	LS	\$128,000	\$128,000
Plant Piping	1	LS	\$194,000	\$194,000
Waste Water Disposal to San. Sewer	1	LS	\$125,000	\$125,000
Sanitary Sewer Improvements	1	LS	\$100,000	\$100,000
Slurry Carbon System <sup>1</sup>	1	LS	\$339,000	\$339,000
Filter Improvements <sup>1</sup>	1	LS	\$77,000	\$77,000
New River Intake <sup>1</sup>	1	LS	\$324,000	\$324,000
Upgrading SCADA System <sup>1</sup>	1	LS	\$300,000	\$300,000
<b>Sub-Total</b>				<b>\$4,609,000</b>
<b>20% Contingency</b>				<b>\$921,800</b>
<b>Total Construction Cost</b>				<b>\$5,530,800</b>
<b>Other Project Costs</b>				<b>\$ 2,263,990</b>
<b>Total Project Cost</b>				<b>\$7,894,790</b>

<sup>1</sup>CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

**TABLE 8-16**  
**ION EXCHANGE CONTINUOUS CONTACTOR ALTERNATIVE**  
**ESTIMATED OPERATING COSTS**

<b>DESCRIPTION</b>	<b>TOTAL/YR</b>	<b>COST/YR</b>
Pumping Costs	78.7 MG	\$1310
Salt Cost	196,800 lb	\$6890
Wastewater Volume Charge	0.315 MG	\$17,610
Sulfate Wastewater Charge	26,200 lb	\$15,020
Resin Replacement Cost	725 cu ft	\$3910
<b>Total</b>		<b>\$44,740</b>
	<b>SAY</b>	<b>\$45,000</b>



TABLE 8-17

**ION EXCHANGE CONTINUOUS CONTACTOR ALTERNATIVE  
PRESENT VALUE OF REVENUE REQUIRED**

A	B	C	D	E	F	G	H	I	J	K	P.V. of Revenue Requirement @ 10%
Year	Total Capital Cost	Year - End Undepr. Factor	Undepriciated Capital	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (B x 3.0%)	Property Taxes @2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	
1	\$7,894,790	0.970	\$7,657,946	17.00%	\$1,301,851	\$45,000	\$236,844	\$153,159	\$1,691,853	\$1,736,853	\$1,578,958
2	\$7,894,790	0.945	\$7,421,103	17.00%	\$1,261,587	\$46,350	\$236,844	\$148,422	\$1,646,853	\$1,693,203	\$1,399,341
3	\$7,894,790	0.920	\$7,184,259	17.00%	\$1,221,324	\$47,741	\$236,844	\$143,685	\$1,601,853	\$1,649,593	\$1,239,364
4	\$7,894,790	0.895	\$6,947,415	17.00%	\$1,181,061	\$49,173	\$236,844	\$138,948	\$1,556,853	\$1,606,025	\$1,096,937
5	\$7,894,790	0.870	\$6,710,572	17.00%	\$1,140,797	\$50,648	\$236,844	\$134,211	\$1,511,852	\$1,562,500	\$970,190
6	\$7,894,790	0.845	\$6,473,728	17.00%	\$1,100,534	\$52,167	\$236,844	\$129,475	\$1,466,852	\$1,519,019	\$857,447
7	\$7,894,790	0.820	\$6,236,884	17.00%	\$1,060,270	\$53,732	\$236,844	\$124,738	\$1,421,852	\$1,475,584	\$757,208
8	\$7,894,790	0.795	\$6,000,040	17.00%	\$1,020,007	\$55,344	\$236,844	\$120,001	\$1,376,851	\$1,432,196	\$668,130
9	\$7,894,790	0.770	\$5,763,197	17.00%	\$979,743	\$57,005	\$236,844	\$115,264	\$1,331,851	\$1,388,856	\$589,010
10	\$7,894,790	0.745	\$5,526,353	17.00%	\$939,480	\$58,715	\$236,844	\$110,527	\$1,286,851	\$1,345,566	\$518,774
11	\$7,894,790	0.720	\$5,289,509	17.00%	\$899,217	\$60,476	\$236,844	\$105,790	\$1,241,850	\$1,302,327	\$456,458
12	\$7,894,790	0.695	\$5,052,666	17.00%	\$858,953	\$62,291	\$236,844	\$101,053	\$1,196,850	\$1,259,141	\$401,201
13	\$7,894,790	0.670	\$4,815,822	17.00%	\$818,690	\$64,159	\$236,844	\$96,316	\$1,151,850	\$1,216,009	\$352,235
14	\$7,894,790	0.645	\$4,578,978	17.00%	\$778,426	\$66,084	\$236,844	\$91,580	\$1,106,850	\$1,172,934	\$308,870
15	\$7,894,790	0.620	\$4,342,135	17.00%	\$738,163	\$68,067	\$236,844	\$86,843	\$1,061,849	\$1,129,916	\$270,493
16	\$7,894,790	0.595	\$4,105,291	17.00%	\$697,899	\$70,109	\$236,844	\$82,106	\$1,016,849	\$1,086,957	\$236,554
17	\$7,894,790	0.570	\$3,868,447	17.00%	\$657,636	\$72,212	\$236,844	\$77,369	\$971,849	\$1,044,060	\$206,562
18	\$7,894,790	0.545	\$3,631,603	17.00%	\$617,373	\$74,378	\$236,844	\$72,632	\$926,848	\$1,001,226	\$180,079
19	\$7,894,790	0.520	\$3,394,760	17.00%	\$577,109	\$76,609	\$236,844	\$67,895	\$881,848	\$958,458	\$156,715
20	\$7,894,790	0.495	\$3,157,916	17.00%	\$536,846	\$78,908	\$236,844	\$63,158	\$836,848	\$915,756	\$136,121
21	\$7,894,790	0.470	\$2,921,072	17.00%	\$496,582	\$81,275	\$236,844	\$58,421	\$791,847	\$873,122	\$117,986
22	\$7,894,790	0.445	\$2,684,229	17.00%	\$456,319	\$83,713	\$236,844	\$53,685	\$746,847	\$830,560	\$102,031
23	\$7,894,790	0.420	\$2,447,385	17.00%	\$416,055	\$86,225	\$236,844	\$48,948	\$701,847	\$788,071	\$88,010
24	\$7,894,790	0.395	\$2,210,541	17.00%	\$375,792	\$88,811	\$236,844	\$44,211	\$656,847	\$745,658	\$75,703
25	\$7,894,790	0.370	\$1,973,698	17.00%	\$335,529	\$91,476	\$236,844	\$39,474	\$611,846	\$703,322	\$64,914
26	\$7,894,790	0.345	\$1,736,854	17.00%	\$295,265	\$94,220	\$236,844	\$34,737	\$566,846	\$661,066	\$55,467
27	\$7,894,790	0.320	\$1,500,010	17.00%	\$255,002	\$97,047	\$236,844	\$30,000	\$521,846	\$618,892	\$47,208
28	\$7,894,790	0.295	\$1,263,166	17.00%	\$214,738	\$99,958	\$236,844	\$25,263	\$476,845	\$576,803	\$39,997
29	\$7,894,790	0.270	\$1,026,323	17.00%	\$174,475	\$102,957	\$236,844	\$20,526	\$431,845	\$534,802	\$33,714
30	\$7,894,790	0.245	\$789,479	17.00%	\$134,211	\$106,045	\$236,844	\$15,790	\$386,845	\$492,890	\$28,247
										<b>TOTAL:</b>	<b>\$13,033,923</b>

\* An annual inflation rate of 3% has been applied to the total O&M expense.

4. Reverse Osmosis

TABLE 8-18  
REVERSE OSMOSIS ALTERNATIVE  
ESTIMATED CAPITAL COSTS

DESCRIPTION	QUANTITY	UNITS	UNIT COST	TOTAL COST
Reverse Osmosis Equipment and Facilities	1	LS	\$2,925,000	\$2,925,000
Plant Piping	1	LS	\$200,000	\$200,000
Waste Water Disposal to San. Sewer	1	LS	\$125,000	\$125,000
Sanitary Sewer Improvements	1	LS	\$100,000	\$100,000
Other Water Treatment Plant Improvements <sup>1</sup>	1	LS	\$1,040,000	\$1,040,000
Sub-Total				\$4,390,000
20% Contingency				\$878,000
Total Construction Cost				\$5,268,000
Other Project Costs				\$2,298,290
Total Project Cost				\$7,566,290

<sup>1</sup>CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

**TABLE 8-19**  
**REVERSE OSMOSIS ALTERNATIVE**  
**ESTIMATED OPERATING COSTS**

<b>DESCRIPTION</b>	<b>TOTAL/YR</b>	<b>COST/YR</b>
Chemical pre- & post- treatment		\$6000
Energy		\$6000
Membrane Replacement 10 Yr. Life		\$47,000
Wastewater Volume	6.3 MG	\$355,000
Wastewater Sulfate Charge	31,590 lb	\$20,000
<b>Total</b>		<b>\$434,000</b>

**TABLE 8-20**  
**REVERSE OSMOSIS ALTERNATIVE**  
**PRESENT VALUE OF REVENUE REQUIRED**

A	B	C	D	E	F	G	H	I	J	K	P.V. of Revenue Requirement @ 10%
Year	Total Capital Cost	Year - End Undepr. Factor	Undepreciated Capital	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (B x 3.0%)	Property Taxes @2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	
1	\$7,566,290	0.970	\$7,339,301	17.00%	\$1,247,681	\$434,000	\$226,989	\$146,786	\$1,621,456	\$2,055,456	\$1,868,596
2	\$7,566,290	0.945	\$7,112,313	17.00%	\$1,209,093	\$447,020	\$226,989	\$142,246	\$1,578,328	\$2,025,348	\$1,673,841
3	\$7,566,290	0.920	\$6,885,324	17.00%	\$1,170,505	\$460,431	\$226,989	\$137,706	\$1,535,200	\$1,995,631	\$1,499,347
4	\$7,566,290	0.895	\$6,658,335	17.00%	\$1,131,917	\$474,244	\$226,989	\$133,167	\$1,492,072	\$1,966,316	\$1,343,020
5	\$7,566,290	0.870	\$6,431,347	17.00%	\$1,093,329	\$488,471	\$226,989	\$128,627	\$1,448,945	\$1,937,415	\$1,202,983
6	\$7,566,290	0.845	\$6,204,358	17.00%	\$1,054,741	\$503,125	\$226,989	\$124,087	\$1,405,817	\$1,908,942	\$1,077,548
7	\$7,566,290	0.820	\$5,977,369	17.00%	\$1,016,153	\$518,219	\$226,989	\$119,547	\$1,362,689	\$1,880,908	\$965,203
8	\$7,566,290	0.795	\$5,750,380	17.00%	\$977,565	\$533,765	\$226,989	\$115,008	\$1,319,561	\$1,853,326	\$864,590
9	\$7,566,290	0.770	\$5,523,392	17.00%	\$938,977	\$549,778	\$226,989	\$110,468	\$1,276,433	\$1,826,211	\$774,492
10	\$7,566,290	0.745	\$5,296,403	17.00%	\$900,389	\$566,272	\$226,989	\$105,928	\$1,233,305	\$1,799,577	\$693,815
11	\$7,566,290	0.720	\$5,069,414	17.00%	\$861,800	\$583,260	\$226,989	\$101,388	\$1,190,177	\$1,773,437	\$621,579
12	\$7,566,290	0.695	\$4,842,426	17.00%	\$823,212	\$600,757	\$226,989	\$96,849	\$1,147,050	\$1,747,807	\$556,905
13	\$7,566,290	0.670	\$4,615,437	17.00%	\$784,624	\$618,780	\$226,989	\$92,309	\$1,103,922	\$1,722,702	\$499,005
14	\$7,566,290	0.645	\$4,388,448	17.00%	\$746,036	\$637,344	\$226,989	\$87,769	\$1,060,794	\$1,698,137	\$447,173
15	\$7,566,290	0.620	\$4,161,460	17.00%	\$707,448	\$656,464	\$226,989	\$83,229	\$1,017,666	\$1,674,130	\$400,773
16	\$7,566,290	0.595	\$3,934,471	17.00%	\$668,860	\$676,158	\$226,989	\$78,689	\$974,538	\$1,650,696	\$359,240
17	\$7,566,290	0.570	\$3,707,482	17.00%	\$630,272	\$696,443	\$226,989	\$74,150	\$931,410	\$1,627,853	\$322,062
18	\$7,566,290	0.545	\$3,480,493	17.00%	\$591,684	\$717,336	\$226,989	\$69,610	\$888,282	\$1,605,618	\$288,785
19	\$7,566,290	0.520	\$3,253,505	17.00%	\$553,096	\$738,856	\$226,989	\$65,070	\$845,155	\$1,584,011	\$258,998
20	\$7,566,290	0.495	\$3,026,516	17.00%	\$514,508	\$761,022	\$226,989	\$60,530	\$802,027	\$1,563,048	\$232,337
21	\$7,566,290	0.470	\$2,799,527	17.00%	\$475,920	\$783,852	\$226,989	\$55,991	\$758,899	\$1,542,751	\$208,473
22	\$7,566,290	0.445	\$2,572,539	17.00%	\$437,332	\$807,368	\$226,989	\$51,451	\$715,771	\$1,523,139	\$187,111
23	\$7,566,290	0.420	\$2,345,550	17.00%	\$398,743	\$831,589	\$226,989	\$46,911	\$672,643	\$1,504,232	\$167,990
24	\$7,566,290	0.395	\$2,118,561	17.00%	\$360,155	\$856,537	\$226,989	\$42,371	\$629,515	\$1,486,052	\$150,872
25	\$7,566,290	0.370	\$1,891,573	17.00%	\$321,567	\$882,233	\$226,989	\$37,831	\$586,387	\$1,468,620	\$135,548
26	\$7,566,290	0.345	\$1,664,584	17.00%	\$282,979	\$908,700	\$226,989	\$33,292	\$543,260	\$1,451,959	\$121,827
27	\$7,566,290	0.320	\$1,437,595	17.00%	\$244,391	\$935,961	\$226,989	\$28,752	\$500,132	\$1,436,092	\$109,542
28	\$7,566,290	0.295	\$1,210,606	17.00%	\$205,803	\$964,039	\$226,989	\$24,212	\$457,004	\$1,421,043	\$98,540
29	\$7,566,290	0.270	\$983,618	17.00%	\$167,215	\$992,961	\$226,989	\$19,672	\$413,876	\$1,406,837	\$88,686
30	\$7,566,290	0.245	\$756,629	17.00%	\$128,627	\$1,022,749	\$226,989	\$15,133	\$370,748	\$1,393,498	\$79,859
										<b>TOTAL:</b>	<b>\$17,298,741</b>

\* An annual inflation rate of 3% has been applied to the total O&M expense.

**TABLE 8-21  
COMPARISON OF ALTERNATIVES**

<b>TREATMENT ALTERNATIVE</b>	<b>CAPITAL COST ESTIMATE</b>	<b>OPERATION &amp; MAINTENANCE COST ESTIMATE (1999)</b>	<b>PRESENT VALUE OF REVENUE REQUIREMENT ESTIMATE</b>
Side Stream Storage (Canyon Lake)	\$12,936,290	\$45,000	\$21,604,304
Groundwater	\$12,663,290	\$25,000	\$20,770,010
Ion Exchange (Co-Current)	\$6,297,290	\$128,000	\$11,529,291
Ion Exchange (Counter-Current)	\$6,379,790	\$100,000	\$11,315,352
Ion Exchange (Continuous Contactor)	\$7,894,790	\$45,000	\$13,033,923
Reverse Osmosis	\$7,566,290	\$434,000	\$17,298,741

As Table 8-21 shows, the groundwater and side channel storage alternative require more initial capital expenditure, while the ion exchange and reverse osmosis alternatives require greater long term operation and maintenance expenses. Considering the groundwater alternative, the overall cost will potentially increase depending on the required location of the wells. This would in turn, affect the cost of land and pipeline. In addition, the success of this alternative is dependent upon the assumption that there is enough groundwater available to meet the required demands and that the water quality is sufficient. Table 8-21 also indicates that in the long term, ion exchange is the most cost effective option.

## CHAPTER 9

### RECOMMENDATIONS

Based on all of the alternatives originally considered for this project, four were determined to provide feasible solutions. They included groundwater blending, ion exchange treatment of the existing water source, reverse osmosis treatment of the existing water source, and side channel storage for blending purposes. These alternatives were further developed and preliminary sizing and design was completed in order to generate estimated project capital and operational costs, as well as develop other issues such as finished water quality, waste generation, impact on current operations, ease of operation, etc. Based on the present value of revenue requirement costs developed in the preceding chapter, we recommend the counter-current ion exchange alternative for treatment of the high nitrate occurrences. We also recommend that CIWC investigate the possibility of obtaining a new or modifying an existing NPDES permit to discharge the ion exchange waste to a receiving stream. This will reduce both the capital and operating costs, as the tables now reflect the cost to discharge the waste to the Sanitary District.